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Original Article

Role of AI in Early Detection of Lung Nodules on HRCT.

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ABSTRACT

Background: Early detection of pulmonary nodules plays a crucial role in reducing lung cancer–related mortality. High-resolution computed tomography (HRCT) is the imaging modality of choice for identifying lung nodules; however, detection of small or subtle nodules is subject to inter-observer variability and radiologist fatigue. Artificial intelligence (AI)–based algorithms have emerged as promising tools to enhance diagnostic accuracy and efficiency.

Aim: To evaluate the role of artificial intelligence in the early detection of lung nodules on HRCT and to compare its diagnostic performance with conventional radiologist interpretation.

Materials and Methods: This prospective observational study was conducted in the Department of Radiology at a tertiary care center. HRCT chest scans of patients clinically suspected of pulmonary pathology were analyzed over a defined study period. Each scan was independently reviewed by experienced radiologists and by an AI-based lung nodule detection software. The number, size, location, and characteristics of detected nodules were recorded. Diagnostic performance parameters including sensitivity, specificity, and detection rate were compared between AI-assisted analysis and radiologist interpretation.

Results: AI-based analysis demonstrated a higher detection rate for small pulmonary nodules, particularly those measuring less than 6 mm, compared to manual interpretation. The combined approach of AI assistance and radiologist review improved overall sensitivity and reduced missed nodules. AI also reduced reporting time and inter-observer variability.

Conclusion: Artificial intelligence serves as a valuable adjunct to radiologists in the early detection of lung nodules on HRCT. Integration of AI into routine radiological workflow can enhance diagnostic accuracy, improve efficiency, and support early diagnosis of lung malignancies.

Keywords*:* Artificial intelligence, Lung nodules, HRCT chest, Computer-aided diagnosis, Early lung cancer detection.

INTRODUCTION

Lung cancer is one of the most common and deadliest malignancies worldwide, with high mortality largely attributed to late-stage diagnosis [1,2]. Early detection of pulmonary nodules, which often represent the earliest radiological manifestation of lung cancer, is critical for improving survival outcomes [3]. High-resolution computed tomography (HRCT) has become the imaging modality of choice for the detection and characterization of lung nodules due to its superior spatial resolution and ability to detect subtle parenchymal abnormalities [4,5].

Despite the high sensitivity of HRCT, accurate identification of lung nodules remains challenging. Small nodules, ground-glass opacities, and perifissural or juxtavascular lesions are particularly prone to being overlooked, especially in the setting of increasing imaging workload and time constraints faced by radiologists [6]. Inter-observer variability further contributes to inconsistencies in nodule detection and reporting, potentially delaying diagnosis and management [7].

Recent advances in artificial intelligence (AI), particularly in machine learning and deep learning techniques, have demonstrated significant potential in medical imaging applications [8,9]. AI-based computer-aided detection (CAD) systems are designed to automatically analyze imaging data, identify suspicious pulmonary nodules, and assist radiologists by acting as a second reader [10].

The integration of AI into thoracic imaging has the potential to enhance diagnostic accuracy, improve reporting efficiency, and standardize radiological interpretation [11,12]. However, the real-world clinical effectiveness of AI in routine HRCT interpretation requires further validation [13]. This study aims to evaluate the role of artificial intelligence in the early detection of lung nodules on HRCT and to assess its impact on diagnostic performance when compared with conventional radiologist interpretation [14,15].

MATERIALS AND METHODS

Study Design and Setting

This was a prospective observational study conducted in the Department of Radiology at Yashoda hospital, Hyderabad, over a period of 6 months (from July 2025 to December 2025).

Study Population

All patients referred for HRCT chest for evaluation of suspected pulmonary pathology during the study period were considered for inclusion.

Inclusion Criteria

- Adult patients (≥18 years) undergoing HRCT chest
- HRCT scans with adequate image quality for interpretation
- Patients with no prior history of lung malignancy

Exclusion Criteria

- Patients with previously diagnosed or treated lung cancer
- History of lung surgery
- Poor-quality or incomplete HRCT scans

Imaging Protocol

HRCT chest examinations were performed using a multi-detector computed tomography (MDCT) scanner. Scans were acquired in the supine position during full inspiration using standard HRCT protocol parameters. Images were reconstructed using thin-section slices and reviewed on a dedicated workstation in lung window settings.

Image Analysis by Radiologists

All HRCT scans were independently reviewed by two experienced radiologists who were blinded to the AI analysis results. Pulmonary nodules were assessed for number, size, location, and morphological characteristics. Discrepancies between the two radiologists were resolved by consensus.

AI-Based Analysis

The same HRCT datasets were subsequently analyzed using an artificial intelligence–based lung nodule detection software. The AI algorithm automatically identified pulmonary nodules and provided measurements including size and location. AI-generated findings were recorded and compared with radiologist interpretations.

Outcome Measures

The primary outcome measure was the detection rate of pulmonary nodules on HRCT. Secondary outcome measures included sensitivity, specificity, and the number of nodules detected in different size categories, particularly nodules measuring less than 6 mm.

Statistical Analysis

Data were entered into a spreadsheet and analyzed using appropriate statistical software. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation. Diagnostic performance parameters of AI and radiologist interpretation were compared. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to inclusion in the study, and patient confidentiality was maintained throughout the research process.

RESULTS

A total of 120 patients who underwent HRCT chest during the study period were included in the analysis. The study population consisted of 72 males (60%) and 48 females (40%), with a mean age of 54.3 ± 11.2 years.

Pulmonary nodules were detected in 68 patients (56.7%). AI-based analysis demonstrated a higher overall detection rate of lung nodules compared to conventional radiologist interpretation, particularly for nodules smaller than 6 mm.

Table 1: Demographic Characteristics of Study Population (n = 120)

Variable	Number (n)	Percentage (%)
Total patients	120	100
Male	72	60
Female	48	40
Mean age (years)	54.3 ± 11.2	—

Table 2: Detection of Pulmonary Nodules by Different Methods

Detection Method	Nodules Detected (n)	Detection Rate (%)
Radiologist interpretation	92	76.7
AI-based analysis	118	98.3
Combined AI + Radiologist	124	103.3*

*Combined method detected additional nodules missed on individual assessment.

AI-based detection showed a statistically significant improvement in the identification of pulmonary nodules compared to radiologist-only interpretation.

Table 3: Size-wise Distribution of Pulmonary Nodules Detected

Nodule Size	Radiologist (n)	AI (n)	Combined (n)
< 6 mm	34	56	60
6–10 mm	38	42	44
> 10 mm	20	20	20
Total	**92**	**118**	**124**

AI demonstrated superior sensitivity in detecting small pulmonary nodules (<6 mm), which were frequently missed on manual interpretation.

Table 4: Location-wise Distribution of Lung Nodules Detected

Lung Location	Radiologist (n)	AI (n)
Right upper lobe	24	30
Right middle lobe	12	16
Right lower lobe	20	26
Left upper lobe	18	24
Left lower lobe	18	22
Total	**92**	**118**

AI showed improved detection in anatomically complex areas such as juxtavascular and perifissural regions.

Table 5: Diagnostic Performance of AI vs Radiologist Interpretation

Parameter	Radiologist (%)	AI (%)	Combined (%)
Sensitivity	78.4	94.6	97.8
Specificity	92.1	88.3	94.5
Accuracy	84.6	91.7	96.2

The combined AI-assisted radiologist approach achieved the highest diagnostic accuracy, demonstrating the complementary role of AI in HRCT interpretation.

Summary of Results

AI-based lung nodule detection significantly improved sensitivity and early identification of small pulmonary nodules on HRCT. When used as a decision-support tool, AI enhanced radiologist performance, reduced missed lesions, and improved diagnostic confidence.

DISCUSSION

Early detection of pulmonary nodules is a critical factor in reducing lung cancer–related morbidity and mortality [1,2]. HRCT plays a pivotal role in identifying lung nodules; however, accurate interpretation is often challenged by small lesion size, subtle attenuation differences, complex anatomical locations, and increasing radiologist workload [6,7].

In the present study, AI-based analysis demonstrated a significantly higher detection rate of pulmonary nodules compared to radiologist-only interpretation, particularly for nodules measuring less than 6 mm. Similar improvements in sensitivity using AI-assisted detection systems have been reported in previous studies [8,10,11].

The combined approach of AI-assisted analysis followed by radiologist confirmation yielded the highest diagnostic accuracy. This supports earlier research emphasizing that AI should function as a decision-support system rather than a standalone diagnostic tool [12,13]. By reducing missed nodules and inter-observer variability, AI enhances diagnostic confidence and reporting efficiency [9,14].

Despite these encouraging results, limitations such as single-center study design and lack of histopathological correlation in all cases must be acknowledged [15]. Further multicentric studies with long-term follow-up are recommended to establish the definitive clinical role of AI in lung nodule detection.

CONCLUSION

Artificial intelligence significantly enhances the early detection of pulmonary nodules on HRCT [10–12]. The combined use of AI and radiologist interpretation offers the highest diagnostic accuracy and has the potential to improve early lung cancer diagnosis and patient outcomes [14,15].

REFERENCES

1. Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2023. *CA Cancer J Clin*. 2023;73(1):17–48.
2. National Lung Screening Trial Research Team. Reduced lung-cancer mortality with low-dose computed tomographic screening. *N Engl J Med*. 2011;365(5):395–409.
3. MacMahon H, Naidich DP, Goo JM, et al. Guidelines for management of incidental pulmonary nodules detected on CT images: Fleischner Society 2017 guidelines. *Radiology*. 2017;284(1):228–243.
4. de Margerie-Mellon C, Onken A, Heidinger BH, et al. Impact of artificial intelligence on radiologist performance for lung nodule detection: A systematic review. *Eur Radiol*. 2020;30(11): 6131–6141.
5. Ardila D, Kiraly AP, Bharadwaj S, et al. End-to-end lung cancer screening with three-dimensional deep learning on low-dose chest CT. *Nat Med*. 2019;25(6):954–961.
6. Nam JG, Park S, Hwang EJ, et al. Development and validation of deep learning–based automatic detection algorithm for malignant pulmonary nodules on chest radiographs. *Radiology*. 2019;290(1):218–228.
7. Jacobs C, van Ginneken B, Scholten ET, et al. Lung nodule detection on CT scans: performance of a computer-aided detection system. *Radiology*. 2014;270(2):571–579.
8. Setio AAA, Traverso A, de Bel T, et al. Validation, comparison, and combination of algorithms for automatic detection of pulmonary nodules in computed tomography images: The LUNA16 challenge. *Med Image Anal*. 2017;42:1–13.
9. Esteva A, Kuprel B, Novoa RA, et al. Dermatologist-level classification of skin cancer with deep neural networks. *Nature*. 2017;542(7639):115–118.
10. Chassagnon G, Vakalopoulou M, Paragios N, Revel MP. Artificial intelligence applications for thoracic imaging. *Eur J Radiol*. 2020;123:108774.
11. Hwang EJ, Park S, Jin KN, et al. Development and validation of a deep learning–based automated detection algorithm for major thoracic diseases on chest radiographs. *JAMA Netw Open*. 2019;2(3):e191095.
12. Lee JH, Goo JM, Lee CH, et al. Deep learning–based computer-aided detection of pulmonary nodules on chest CT: Clinical impact on radiologists' performance. *Radiology*. 2020;297(3): 626–636.
13. McKinney SM, Sieniek M, Godbole V, et al. International evaluation of an AI system for breast cancer screening. *Nature*. 2020;577(7788):89–94.
14. Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts HJWL. Artificial intelligence in radiology. *Nat Rev Cancer*. 2018;18(8):500–510.
15. van Ginneken B, Setio AAA, Jacobs C, Ciompi F. Off-the-shelf convolutional neural network features for pulmonary nodule detection in computed tomography scans. *IEEE Trans Med Imaging*. 2015;34(2): 541–549.